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ABSTRACT

This publication, a pamphlet included in the B'nai B'rith Occupational Brief Series, directs its attention to man's attempts to develop greater knowledge and understanding of life's secrets so that he can improve his health and well-being, conserve and increase the fruitfulness of the earth, and cope with disease and pests. Life scientists study all forms of plant and animal life. The nature of work, the specialties and various ways in which these specialties are classified are presented and each is described briefly. The educational requirements for a career as a biological scientist are pointed out as are some of those personal qualifications needed for success. Facts about seeking employment, women's role in the professions, earnings, advantages and disadvantages, and employment outlook are discussed. A selected bibliography is included. (EB)

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B'NAI B'RITH CAREER AND COUNSELING SERVICES

BBCCS Pamphlet #1019

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A CAREER IN THE BIOLOGICAL SCIENCES

by NEAL H. ROSENTHAL

Assistant Chief, Division of Manpower and Occupational Outlook, Bureau of Labor Statistics, U. S. Department of Labor.

BIOLOGICAL SCIENCE, the study of living things, is of major importance to mankind. We, as living creatures, are concerned with understanding our own life processes as well as the many living things we depend on for food, clothing, and shelter—the three basic necessities of life. Biological scientists are vital to man's attempt to develop greater knowledge and understanding of life's secrets so he can improve his health and well-being, conserve and increase the fruitfulness of the earth, and cope with disease and pests.

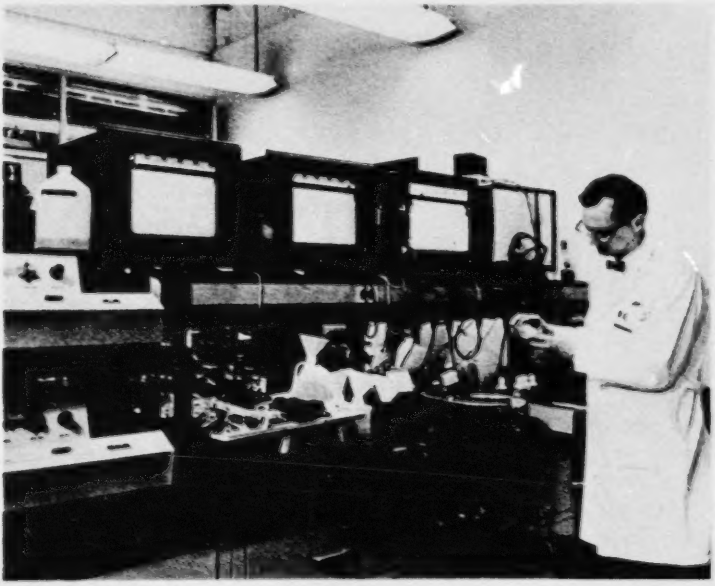
NATURE OF THE WORK

BIOLOGICAL SCIENTISTS, also called life scientists, study all forms of plant and animal life. They study the life processes of living things such as reproduction and growth; evolutionary development; and the functioning of various organs and parts of living things. Because of the very large number of plants and animals and the multitude of factors that are studied, biological scientists usually specialize in a particular area of work.

Specialists in the biological sciences may be classified according to three areas of work—basic biological science, agriculture, or medicine. This career brief focuses primarily on basic biological science. The work of scientists in agriculture and medicine however, is closely related to those in basic biological science and, therefore, it would be incomplete to exclude them from a discussion of biological science careers.

Biological scientists are engaged in a variety of work activities. Nearly one-half do some type of research work. Many in this type of work conduct basic research designed to add to our knowledge

Analytical studies conducted in the medical laboratories at ICI America, Inc. utilize this equipment. In a few minutes, as many as 40 samples can be analyzed for 12 different constituents.



ICI America, Inc., Wilmington, Del.

of living things without necessarily considering the practical results of their discoveries. Other research biologists are engaged in applied research; they use the discoveries of basic research to develop new products that are useful to man. Some manage and administer research activities.

Large numbers of biological scientists teach in colleges and universities. Many of those engaged in teaching devote a great deal of their time to research. Such activity is generally encouraged by colleges and universities.

Biological scientists also manage and administer activities other than research and development. Some manage arboretums, forests, or wildlife refuges. Others direct programs concerned with testing the quality of foods, drugs, or other products.

Small numbers of life scientists work in activities such as inspecting, writing, and consulting. The relatively few biologists employed in museums identify, classify, and prepare specimens for exhibition, and write monographs on groups of plants and animals that they study. They may also go on expeditions to collect specimens.

The specialties of biological scientists may be classified according to the type of organism studied or the area of study such as a particular life process or bodily function. The few biological scientists who are called biologists, rather than members of a specialty group, are generally college professors who teach basic courses in plant and animal sciences. The specialties classified by the type of organism studied are generally grouped in one of three broad categories—botany, zoology, or microbiology.

Botanists study the plant world. Within this field, scientists known as taxonomists classify and identify plants. Morphologists are concerned with plant structures, and plant physiologists with plant activities.

Zoologists investigate the animal world. Some zoologists, particularly those in colleges and universities and in museums, may be concerned with all types of animal life. Others specialize in a particular group of animals. Mammalogists are experts in the study of mammals, ornithologists study bird life, ichthyologists study fish life, and herpetologists study reptiles and amphibians. Zoologists in these specialized fields may study classification, origin, life processes, and diseases. Others may study the relationship of the living organisms in their specialty to other types of animals.

Microbiologists study bacteria, viruses, molds, yeasts, and other microorganisms. These scientists study organisms under microscopes and with a variety of other equipment. They identify and classify all sorts of microscopic organisms. Some are concerned with the effects of antibiotics on bacteria. Others specialize in the study of viruses (virology), the study of fluids in plants and animals (serology), or the study of microorganisms in the soil (soil bacteriology). Some microbiologists specialize in microorganisms that are useful to man such as those involved in the fermentation of beer and wine.

An assistant professor of microbiology collects fractions from sucrose gradient on which viral antigens were separated.

National Institutes of Health, Bethesda, Md.

The specialties classified by area of study are numerous. The following paragraphs include a description of some of these biological specialties.

Anatomists are concerned with the structure and life processes of plants and animals. Some study living cells (cytology) and others investigate tissues and organs (histology). Anatomists study structures that vary from microscopic size to those that are visible to the naked eye. They may specialize in human anatomy, the anatomy of a particular species of animal, or in the structure of a particular species of the plant kingdom. Some compare relationships between plants and animals.

Embryologists are concerned with the development of an organism from the fertilized egg to the complete organism. They may study this development from several aspects including chemical, physiological, and genetic. They investigate the development processes and causes of abnormalities during the development period.

Ecologists study living things in relation to their environments and each other. They may study the effects of such factors as temperature, sunlight, and soil on the distribution of living things throughout the world. Some ecologists specialize in animal life and others in plant life.

Geneticists study heredity. Some do research to discover additional knowledge of the mechanism of heredity. Others are concerned with breeding new variations of plants and animals.

Pathologists study the causes and effects of disease. They may be concerned with such factors as the effects of diseases on bodily functions, or the effects of parasites and insects on cells and tissues. Some pathologists study plants (plant pathologists), and others study animals.

Physiologists study the functioning of living things. They may be concerned with the functioning of cells, tissues, or organs, or the effect of environmental factors on the functioning of living things. Some specialize in the physiology of plants, others in animals, and some in human physiology. Physiologists may also specialize in one of the life systems such as the digestive, circulatory, or reproductive systems.

Pharmacologists investigate the action of drugs and chemicals which may be useful in the prevention or cure of disease. They carry out experiments on new drugs and use various experimental devices to test the effects of drugs.

Biologists perform surgery as a part of their investigations on gastric ulcers.

The Upjohn Company, Kalamazoo, Mich.

Biochemists apply the knowledge of chemistry to biological problems. They investigate life processes, cellular reproduction, metabolism, and genetics from the view of chemistry. They also deal with enzymes, proteins, carbohydrates, fats, and other foodstuffs that living organisms use to grow.

Biophysicists study the properties of living cells and organisms from the aspect of physical force that may affect them—such as heat, light, radiation, and electricity. They use instruments such as electron microscopes and X-ray diffraction equipment to study living cells.

LOCATION OF JOBS

THE NUMBER OF BIOLOGICAL SCIENTISTS EMPLOYED in the United States in 1970 totaled about 180,000. An estimated 70,000 of these workers were employed in the basic biological sciences.

About three-fifths of all biological scientists worked in colleges and universities. Many of these worked full-time in research; others combined research and teaching. State agricultural colleges and experimental stations operated by these schools employed large numbers of agricultural specialists, including agronomists, horticulturists, animal husbandry specialists, and entomologists.

More than 25,000 biological scientists worked for federal government agencies in 1970; about two-thirds of them worked in the Department of Agriculture. The Department of the Interior also employed large numbers; nearly all the fish and wildlife biologists in the Federal Government were employed by this agency. Other large Federal employers of biological scientists included the Department of Defense and the National Institutes of Health.

Employment of biological scientists in State and local governments combined totaled more than 20,000 in 1970. Many of these scientists were fish and wildlife specialists, microbiologists, and entomologists working in conservation and plant breeding. Some also served as food and drug inspectors investigating restaurants and cafeterias and food processing plants. Others checked into the purity of drinking water.

More than 25,000 biological scientists worked in private industry in 1970. The industries employing the largest numbers were manufacturing firms producing pharmaceuticals, industrial chemicals, and food products.

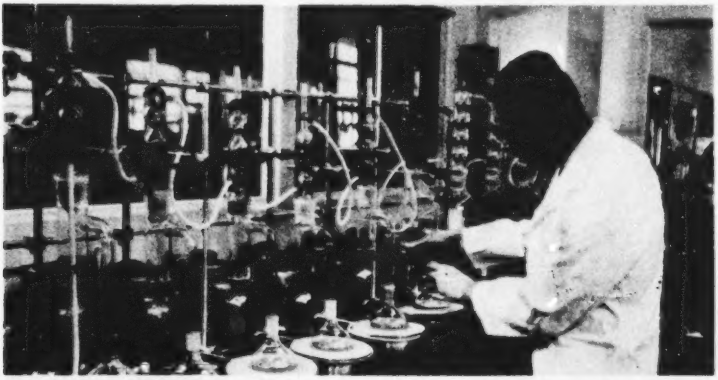
Biological scientists also worked for non-profit organizations, primarily research organizations. A few were self-employed as consultants.

Biological scientists are employed in all states; however, about one-third are located in five states—California, Illinois, Maryland, Pennsylvania, and New York. Two metropolitan areas, Washington, D. C. and New York City, were the location of employment for more than one-tenth of all biological scientists.

EDUCATIONAL REQUIREMENTS

THE EDUCATIONAL REQUIREMENTS FOR A CAREER as a biological scientist depend to a great extent upon the individual's specialty and the type of activity in which he intends to work. However,

Life scientists in industrial firms use the distilling process to determine the amount of specific ingredients in a product.



Kellogg Company, Battle Creek, Mich.

young persons contemplating a career in the biological sciences should plan to study for their master's, and preferably the Ph.D., degree in their major field of interest. Advancement opportunities for biological scientists without advanced degrees are generally limited.

For college teaching and to conduct high level research, a Ph.D. degree is usually necessary. Top level management and administrative jobs that require a person with training in the biological sciences also are generally filled by scientists with the Ph.D. degree.

In order to qualify for a position in applied research, the master's degree is often suitable. This degree is also satisfactory for some teaching positions in colleges and universities, especially in junior and community colleges. Advancement opportunities for persons with the master's degree, however, are generally best in the Federal Government and in private industry.

Despite the emphasis on advanced degrees in the biological sciences, many entry jobs can be filled by those with only the bachelor's degree. Jobs for these workers generally are found in testing the quality of products, in technical sales jobs, and as research assistants. Some new graduates with the bachelor's degree are able to find jobs as high school teachers if they take additional training to obtain a state teaching certificate.

High school students considering a career in the biological sciences should take the courses that are required to meet the admission requirements of most colleges and universities. A variety of subjects including science and the humanities should be

studied to serve as a background for the college education. In general, a high school curriculum should be planned that includes as many courses as possible in science and mathematics and 2-4 years of a foreign language.

Some students in high school obtain part-time work, paid or volunteer, during the school year, and full-time work during summer vacations in work related to biological science. In a number of B'nai B'rith Career and Counseling Services offices, high school boys and girls considering careers as biological scientists have the opportunity to meet and spend time with B'nai B'rith Career and Counseling Services advisors who are successfully employed in the field.

In general, Jewish youth seeking a career in the biological sciences are not hampered because of religion. Today, nondenominational colleges and universities offering training in the biological sciences select applicants primarily on the basis of merit. The proportion of Jewish affiliated high school youth planning to study the biological sciences, however, is lower than for the general population (especially for Jewish females) according to a study conducted by the B'nai B'rith Career and Counseling Services, in co-operation with B'nai B'rith Women, entitled *The College and Career Plans of Jewish High School Youth*. Career opportunities for minority youth in this specialty are increasing.

STUDENT AIDS

STUDENTS WITH ABILITY who wish to pursue a career in the biological sciences should not drop their career aspirations because of a lack of funds. Although college undergraduate and graduate training can be costly in terms of time and money, student aid resources are increasing, particularly in the area of educational loans. Graduate students in the biological sciences usually have opportunities to earn some of their expenses while at school.

A major student reference source providing information about student aid is *Scholarships, Fellowships and Loans*, authored by S. Norman Feingold, and published by the Bellman Publishing Company, P.O. Box 164, Arlington, Mass. This company also issues the *Scholarships, Fellowships and Loans News Service*, a quarterly devoted to reporting new developments in student aid funds as they are established. The selected bibliography at the end of this career brief lists these publications, as well as many others that provide information on sources of funds available for youth who need financial help and are seeking a career in the biological sciences.

Antibiotics might be used to control gingivitis in individuals who cannot brush their teeth, according to University of Michigan scientists.

National Institutes of Health, Bethesda, Md.

PERSONAL QUALIFICATIONS

AMONG THE PERSONAL QUALIFICATIONS needed for a successful career in the biological sciences is curiosity and intense interest in all aspects of science. A systematic approach to solving problems is also needed as well as the patience to pursue an objective for a long period of time. For example, the research life of many biologists has been, and will be, spent seeking the causes and cures for cancer.

The ability to work independently is almost a necessity for a successful career in biological science. Since one often works as a member of a team, however, the ability to get along well with others is also important. Writing skill can be a very helpful asset, since report writing is an essential part of the biological scientist's work.

If a prospective biological scientist plans to pursue a teaching career, it is desirable to have the ability to speak well and have the type of personality that inspires enthusiasm and arouses the interest of students.

SEEKING A JOB

COLLEGE PLACEMENT OFFICES of colleges and universities are generally the best source of assistance in finding a job directly after college. Placement offices, in addition to knowledge of specific openings, conduct elaborate programs of campus interviews. In many schools, hundreds of companies in private industry come to the college to interview job candidates with specific academic backgrounds. Students with an inclination towards employment in public service can also make use of campus interview programs. The Federal government, and to an increasing extent, State and local governments are coming to college campuses to seek out individuals to meet their manpower needs. For beginning jobs in Federal, State, or local government, a Civil Service examination is required. Students with strong inclinations toward public employment should find out the dates examinations are given and take them several months prior to graduation. This procedure can eliminate long waiting periods between graduation and employment.

College professors can also provide assistance to college seniors making plans after graduation. Many professors have personal contacts in private industry and government that have been established through many years of professional association. Professors often are asked for names of well qualified individuals who will be seeking a job after graduation.

Persons also can learn about openings by attending local and national professional meetings and by watching classified advertisements that appear in professional journals. Teaching jobs can be found by direct application to colleges and universities and through teacher placement agencies in addition to some of the methods discussed above.

WOMEN

WOMEN REPRESENT A LARGER PROPORTION of workers in the biological sciences than in any of the other natural sciences. An estimated 10 per cent of all biological scientists are women. Colleges and universities are, perhaps, the largest employers of women biologists. In general, opportunities and employment outlook for women in the biological sciences are similar to those for men.

EARNINGS

STARTING SALARIES FOR BIOLOGICAL SCIENTISTS with the bachelor's degree generally range between $7,000 and $8,500 a year in 1972, according to the limited information available. New graduates with the master's degree usually receive starting salaries of about $500 a year higher. New Ph.D. graduates employed as college and university teachers generally receive $8,000 to $9,000 a year. New Ph.D. graduates beginning their work career in private industry generally receive somewhat higher starting salaries.

The median annual salary for biological scientists was $15,000 in 1970, according to the National Science Foundation's *National Register of Scientific and Technical Personnel.* Less than one-fourth of all biological scientists earned under $11,300 a year and about one-fourth earned $20,000 or more.

The type of employer is an important factor affecting the earnings of biological scientists. The following table gives the median salaries of biological scientists in 1970, by employment setting, as reported in the 1970 *National Register of Scientific and Technical Personnel.*

TYPE OF EMPLOYMENT SETTING	SALARY
Total All Employers	$15,000
Educational Institutions	12,200[1]
Federal Government	16,300
Other Government	13,200
Non-Profit Organizations	17,000
Industry and Business	17,000
Self-Employed	25,000
Other	13,000

[1] For An Academic Year

The figures show that the highest wages are earned by self-employed biological scientists. Salaries are higher on the average in non-profit organizations and in industry and business. Salaries were lowest in State and local government (see Other Government).

ADVANTAGES AND DISADVANTAGES

THE WORKING CONDITIONS OF BIOLOGICAL SCIENTISTS vary depending primarily on the type of employer and position. However, most biologists have 40-hour work weeks, 8 hours for 5 days, in a laboratory setting. Sometimes, however, there is a need for overtime work in connection with experiments that have to be observed on a round-the-clock basis. In general, such conditions are similar to those of scientists in other fields. Some biologists, however,

may work out of doors for long periods by themselves or others in the laboratory collecting material for analysis.

Biological scientists must often perform their duties under some pressure. For example, those working in the development of new pharmaceuticals are in a business in which keen competition exists for getting new products on the market before other companies. Biologists in these companies must take great care to assure proper testing of the proposed new products, but still within the confines of the rapid testing necessary for early marketing of the products.

In some fields, such as microbiology, there may be danger of some contagious or infectious diseases. However, such danger is minimal because great precautions are taken to protect the workers.

Biological scientists receive the same vacations and sick leave benefits as other employees. Generally, they also receive time off to attend professional meetings. They are provided the same opportunity as other employees to participate in health, retirement, and insurance plans.

EMPLOYMENT OUTLOOK

EMPLOYMENT OF BIOLOGICAL SCIENTISTS in the United States should increase very rapidly through the 1970's. Openings for biologists will be plentiful because, in addition to large numbers needed for growth of the profession, many will be needed each year to replace those scientists who retire, die, or transfer to other fields of work. According to the U. S. Department of Labor, openings for biological scientists will average more than 15,000 each year through the 1970's. Annual openings for biological scientists are expected to number more than those for any other natural science occupation.

Along with the large number of job openings, however, the number of young people receiving college degrees in the life sciences also is large and rapidly growing. In 1970 about 10,400 bachelor's degrees, 3,100 master's degrees and nearly 900 Ph.D.'s were awarded in the life sciences. The U. S. Office of Education projects an increase of about 50 percent in the number of bachelor's and master's degrees to be obtained between 1970 and 1980; the number of Ph.D.'s are projected to nearly double. The number of new college graduates in the biological sciences, together with graduates of other curricula such as chemistry, seeking jobs as biological scientists, will likely be even greater than the number of job openings. As a result, keen competition will likely result for the better positions.

Favorable opportunities can, nevertheless, be expected for

biological scientists with advanced degrees. The two major factors that underly growth of the field, (1) growth of research and (2) growth of college enrollments, will create a strong demand for those with Ph.D.'s to conduct research and teach. Those with only bachelor's degrees will be affected most by increased competition.

Expansion of research and development programs will create jobs for biological scientists in certain specialties. Rapid growth is expected in medical research programs. Biological scientists will be in great demand to fill positions in expanding research programs concerned with the causes and cures of cancer, heart disease, and birth defects. With man's continuing ventures into space, more and more research will be conducted to study the biological, physical, and chemical effects of space travel on man. The design of experiments in this barely touched field will require many highly trained individuals with keen minds.

Biological scientists will also be involved in solving problems related to controlling pollution of the country's rivers, lakes, and streams, the effects of exposure to radiation, and the effects of smog and methods of controlling it. More biologists in agricultural specialties will be called upon to help increase our supply of food in inexpensive ways which will help the poverty stricken, both in this country and abroad, meet daily nutritional requirements.

Private industry is expected to expand research programs as a result of the increasingly stringent Federal health regulations. Thus, large numbers of pharmacologists, microbiologists, and other specialists will be needed by pharmaceutical firms manufacturing vaccines, antibiotics, and other drug products to perform the necessary research and testing before new drugs are made available to the public. Also competition among pharmaceutical houses should result in great expansion of their research programs to develop new products. The problem of killing insects and bacterial pests without harming desirable life will also require the employment of many entomologists by firms manufacturing insecticides. Plant pathologists will be needed by food processing companies to solve problems relating to losses due to plant diseases.

Although openings will not be numerous, biologists will be needed to staff museums and botanical gardens.

Underlying the anticipated rapid growth of biological scientists is the great increase in college and university enrollments as our population grows and as a greater proportion of young people attend college. Although the demand for college teachers will be primarily for those with the Ph.D. degree, biological scientists with master's degrees will qualify for some teaching positions,

DuPont scientist examines apple seedling for scab disease. Healthy plant at right has been treated with a new fungicide which has proved to be highly effective for preventing this disease.

E.I. duPont de Nemours & Co., Wilmington, Del.

especially in junior colleges. There are increasing career opportunities for Jewish and other minority youth in this field.

COUNSELING

MANY YOUNG PEOPLE find educational and vocational counseling helpful in choosing a career. If you are interested in assessing your assets and limitations, you may wish to avail yourself of counseling services in your own school or in a number of agencies that provide professional counseling services. You may wish to get in touch with one of the B'nai B'rith Career and Counseling Services field offices, or any counseling agency approved by the International Association of Counseling Services, Inc., located in your geographical area. A list of these agencies is published in their *Directory of Approved Counseling Agencies*. Copies of this book are in many public and private libraries.

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